

the sun's limb, where observations indicated it should be. As it cannot be considered that from present data we are certain as to the true time of perihelion passage within this amount, it seems that we have no reason to suppose that there has been any effect of retardation experienced. In fact the deviation shown by the ellipse is opposite to that which would have been the result of such retardation.

It should be remarked (as being of interest) that at the instant of entry upon the sun, the comet was about 1,600,000 miles from its surface (the true anomaly being about 90°).

The perihelion passage took place less than two hours after. The whole half circuit of the sun (from $v = -90^\circ$ to $v = +90^\circ$) occupied but $3\frac{1}{2}$ hours. It is certainly an interesting fact to consider, that an object of such limited dimensions and small gravity can pass at such an enormous velocity for hours through the sun's upper atmosphere, and emerge with so slight an effect on its motion as this body has apparently experienced.

An additional argument in support of my conclusion that little or no disturbance was suffered can be drawn from the fact that the comet, after passing this ordeal, is departing with nearly parabolic velocity, as the slight variation of the eccentricity from unity in the above elements proves.

Another interesting point which I would simply indicate, without discussing, is the bearing of the visibility of the comet clear up to the sun's edge. Prof. Pickering has suggested that the light which rendered it visible in this position must have been nearly all from the comet's own incandescence, scarcely any of it from reflection of the sun's light.

I think that the orbits which I have given may be considered as setting at rest completely the idea of identity of the present comet with those of 1668 and 1843. I say nothing of that of 1880, since there, although the hypothesis of its identity has been entertained in some quarters, it cannot for a moment be regarded as tenable. I have elsewhere shown that the deviations between the observations in 1880 and any hypothesis involving an ellipse of less than ten years' period for that comet, are too large to be considered for an instant as probable. The hypothesis of identity with comet 1880, I, may therefore be left to the sensation-mongers.

I inclose a copy of the *Science Observer Circular*, the regular issue of which will be out in a few days. The figures I have here given differ very slightly from those in the printed circular, but you may regard what I give in this letter as the latest. The elliptical orbit will dispose of the systematic deviations in the table (columns $\phi - c$) completely, and leave only the unavoidable observation errors.

You may make what use you please of this, except to treat it as a formally-prepared paper.

S. C. CHANDLER, Jun.

INFLUENCE OF "ENVIRONMENT" UPON PLANTS

IN the *Indian Forester* for July, 1882, Dr. Brandis, Director of the India Forest Department, has given the following interesting particulars as to the change in the season of flowering of the Australian acacias introduced in the Nilgiris:—

"*Acacia dealbata* was introduced on the Nilgiris before the year 1845. Col. Dun, the owner of many houses in Ootacamund, had planted several trees in his compounds, probably several years before 1845, but the tree was by no means common, and as late as 1855 was sold at the Government gardens, at two annas a plant. A curious fact regarding the flowering of this tree has been observed:—In 1845, and up to about 1850, the trees flowered in October, which corresponded with the Aus-

tralian flowering time; but about 1860 they were observed to flower in September; in 1870 they flowered in August; in 1878 in July, and here, this year, 1882, they have begun to flower in June, this being the spring month here, corresponding with October in Australia. All the trees do not flower so early, because at various times seeds have been imported from Australia, and the produce of these would of course flower at the same time as the parent trees in Australia, until acclimatised here.

"Having watched the flowering of these trees for nearly forty years, there cannot be any doubt in the matter; and it is a curious fact that it should have taken the trees nearly forty years to regain their habit of flowering in the spring. Commencing in October, our autumn, it has gradually worked its way back to summer, and finally to spring; probably it will remain at this point."

I have tried to see whether any similar change of season could be traced at Kew.

Acacia dealbata can only be grown under glass with us. It forms a small tree in the Temperate House, and is a splendid object when in full flower. This usually takes place in early spring or towards the end of winter, say about February. Sir Joseph Hooker observed that *A. dealbata* and *A. decurrens*, var. *mollis* (which are closely allied species), flowered at the same time in Tasmania. In Aiton's *Hortus Kewensis* (1813, *A. decurrens*) is said to have been introduced in 1790 by Sir Joseph Banks, and to flower in May-July. The evidence, then, as far as it goes, would seem to indicate that the flowering time had also progressively worked back in England, though under more artificial conditions.

W. T. THISELTON DYER

THE MAGNETIC STORM AND AURORA

THE telegraphic system of this country has, since

Friday morning last, been disturbed in a way that far exceeds anything of the kind that has ever happened before. Very powerful electric currents have been swaying backwards and forwards through the crust of the earth, taking all telegraphic circuits in their progress, and entirely stopping communication. Communication has been maintained only where it was possible to loop together two wires, so as to avoid the use of the earth altogether. The electric storm commenced on Thursday, but it reached its climax on Friday morning (November 17) between 10 and 11 a.m. The currents measured over 50 milliampères, which is five times greater than the ordinary working currents. They have repeated themselves at intervals ever since, but have scarcely attained such an intensity as on Friday morning.

Mr. Preece, whose experience in examining earth currents now extends over a period of thirty years, asserts that this storm was the most terrific he has ever observed. It was characterised on Friday by a rapid succession of alternate waves of great strength.

Both the storm and the aurora seem to have extended to America; the Philadelphia correspondent of the *Times* telegraphs under date November 19:—

"The electrical storm which began to derange the telegraph wires on Friday last still continues, though with less intensity. It spread through Canada and the greater part of the United States, as far west as Utah. The electricians say that the disturbance was unlike any heretofore known, acting upon the wires in strong waves, which produced constant changes in the polarity of the current. A magnificent aurora appeared on Friday night and was visible at all points, except where clouds obscured it. Cold weather, with snow, accompanied the storm in many places."

We have received many letters on the auroral phenomenon of Friday last; as introductory to these we give the following communication from Mr. W. H. M. Christie,

the Astronomer Royal, under the title of "Magnetic Storm, Aurora and Sunspot".—

A REMARKABLE magnetic storm, preceded by several days of considerable magnetic disturbance, was observed here on November 17. It commenced suddenly—November 16, 22h. 15m. G.M.T.—with a great decrease in all the magnetic elements, the declination being diminished by more than 1° , the horizontal force by more than 1-100th part, and the vertical force by nearly 1-100th part. From 4h. to 7h., and also from 11h. to 17h., the motions were large and violent, the range exceeding 2° for the declination, and 1-50th part for the horizontal and vertical force. Earth-current disturbances were also recorded, corresponding both in time and magnitude with the magnetic changes.

In the evening, as soon as it was dark, a brilliant aurora was seen, commencing with a bright glow of red light extending from the north and west beyond the zenith, interspersed with pale green phosphorescent light and streamers. At 6h. 4m. a very brilliant streak of greenish light about 20° long appeared in the east-north-east, and, rising slowly, passed nearly along a parallel of declination, a little above the moon, disappearing at 6h. 5m. 59s. in the west, about two minutes after it was first seen. The whole aurora had faded away by about 7h., but it burst out again at 11h. 45m., when an auroral arch, with brilliant streamers reaching nearly to the zenith, was seen from north-north-east to north-west. It faded away about 12h. 10m.

A remarkable sun-spot, visible to the naked eye, was seen on the sun on November 17 and following days, photographs being obtained on November 18, 19, and 20. Its dimensions on November 18, when it was near the central meridian, were: Length $194''$, breadth $130''$, area of umbra 735, of whole spot 2470 (expressed in millionths of the sun's visible surface), and its position: Heliographic latitude 19° N., longitude 121° . Its spectrum showed C, F, D₃, and the D lines reversed over the principal nucleus, C and F being extremely bright, and D₁, D₂, D₃ doubly reversed. It slightly diminished in size on the two following days. This is the largest spot that has yet been photographed at Greenwich.

Another very active magnetic disturbance commenced on November 19, soon after midnight, and at noon to-day (November 20) it is still in progress, all the elements being greatly disturbed. W. H. M. CHRISTIE

Royal Observatory, Greenwich, November 20

AN extensive aurora occurred last night, though I cannot pretend it was well seen here, both clouds and smoke preventing that. About sunset, and before any aurora had manifested itself, the smoke of the city was simply fearful on every side, rising in enormous volumes, through the calm air from a general bed or bank of it, blue gray below, brown above, that stood ten degrees high on every side in impervious thickness, as seen from the top of the Calton Hill. And no wonder that we neither imprison, nor even fine, those who wilfully thus besmirch the skies and poison the air of the people, when the chief offender was a chimney in the prison establishment itself; a chimney built like an ornamental watch-tower on a medieval Norman castle, but now sending up the most atrociously black column of pitchy coal smoke of all the chimneys around, and in vortex whirls that rose up to and fouled the very zenith sky; leaving in fact no portion whatever of the celestial hemisphere where a pure, unadulterated, and irreproachable optical observation of any astronomical phenomenon could be made, to compare with one through a natural, clear atmosphere of oxygen, nitrogen, and water gases.

About 8 or 9 o'clock aurora began to forcibly manifest itself, chiefly at heights of above 15° or 20° , smoke forbidding direct view lower down. Yet the aurora there must have been exceedingly bright, for the cirro-cumulus clouds above that elevation were often brilliantly illuminated from below, as by a morning dawn. The brightest displays occurred about midnight, and more in the north-east than the usual north-west direction. They seemed all to be of the usual monochrome, citron colour, and mostly took the form of needle-shape jets shooting upwards

from a low, but broad circular arc, which they themselves assisted in forming; with this peculiarity too, that while no dark space was seen below the arc, as so often occurs, such a space, eminently and distinctly aurorally dark, was formed near the middle of the north-east arc itself, in the shape of a black break in that arch, of about five or six degrees wide, and sharply terminated on either side, while no other part of the sky, whether clear, cloudy, or smoky, could be called more than gray in its degree of darkness.

Auroras of one kind or another have been so frequent here for several weeks past, that, taken in connection with the many large sun-spots, I trust Prof. Simon Newcomb will be now quite satisfied touching the philosophic doubt he expressed a few years ago in his "Popular Astronomy," published during the dark, aurora-less nights of 1876-7. For he, at that time, hesitated to consider the past auroras of, and about, 1870 a consequence of, or anything more than a coincidence with, that maximum period of sun-spots; but showed his kindly feeling for the hypothesis by saying, that if the auroras became numerous again at the next maximum of sun-spots, the connection of the two phenomena would stand on a much surer basis.

Now sun-spots have been of late so large and frequent that I have had not a few letters and communications about them. The last such party was a brace of newspaper reporters, who came together, open-mouthed; for having heard from country correspondents that spots had been discovered by them with the naked eye on the sun, they came to ask me whether it could be true!

Wherefore I could only tell them that it was exactly what should be at this time; and I pointed their attention to a framed and glazed copy of my map of the temperatures, and rise and fall of the sun-spot numbers from 1826 to 1878, its date of publication; but with the sun-spot curve carried forward in outline, and marked with a future maximum for 1882.

C. PIAZZI SMYTH,

Astronomer Royal for Scotland

15, Royal Terrace, Edinburgh, November 18

OTHER correspondents will doubtless communicate to you their observations upon the enormous sunspot now visible, and the magnificent aurora witnessed on Friday night, the 17th inst. My object in writing is to contribute a few notes respecting the grand magnetic storm registered by the Kew magnetographs. The disturbance commenced about 8.30 p.m. on the night of Saturday, the 11th inst. Throughout the whole of Sunday, Monday, and Tuesday the magnet continued slowly oscillating through arcs of about 20° on either side of its normal position. On Wednesday and Thursday the vibrations were frequent, but very small, partaking rather of the nature of tremors. About 10.30 a.m. on Friday the storm became violent, and from that hour up to 5.30 a.m. of Saturday, the oscillations of the magnet and the changes of force were incessant and frequently enormous, the declination needle ranging at times through almost 2° . Correspondingly large variations were also exhibited by the bifilar and balance magnetometer. The largest deflections were between midnight and 5 a.m. of Saturday. Through that day the movements were somewhat more sluggish, and from 2 a.m. of yesterday up to 1 a.m. this morning (Monday) the disturbance was but trivial; it has now become again intense, and at the time of writing (noon) it is found that the needles are moving in arcs extending beyond their limits of registration. Observing the large sun-spot yesterday, it was seen that the image projected upon a screen exhibited traces of coloration, yellow and red, in parts of the penumbra; this was noticed both with the photo-heliograph and a Dollond refractor by two observers; probably it will not have escaped the notice of other correspondents. The electrograph does not show any particular disturbance of atmospheric electricity during Friday night's aurora. The tension was much higher and more variable during the dense fog of the succeeding morning. G. M. WHIPPLE

Kew Observatory, November 20

AN aurora was seen here last night. At about 5 o'clock p.m. I was told the "northern lights" were visible, and found that patches of rose-coloured clouds were forming in both the east and west, the larger and brighter portion being in the latter part of the sky. At times these were varied by a white glow, and occasionally there seemed a disposition on the part of the red patches to form into columns or beams. This, however, was never perfected, and no corona actually formed. At a little before 6 o'clock a strange and most unusual phenomenon was

seen. I happened to turn to the south, where the moon (with a very pronounced *lumière cendrée* on its dark part) was nearly on the meridian, when I saw a spindle-shaped beam of glowing white light, quite unlike an auroral ray, had formed in the east. As I looked this slowly mounted from its position, rose to the zenith, and passed it, gradually crossing apparently above the moon, and then sank into the west, slowly lessening in size and brilliancy as it did so, and fading away as it reached the horizon. The peculiar long spindle shape, slow gliding motion and glowing silver light, and the marked isolation of this cloud from the other portions of the aurora made it a most remarkable object, and I do not recollect in any former aurora to have seen anything similar. About 6 o'clock the aurora gradually died away, to revive again at 9 in the shape of a white semicircle of light in a point north by west, which did not last long. Owing to moonlight, but little could be done with the spectroscope with a wide slit on the most glowing parts of the red patches only the usual green line, with a faint continuous spectrum towards the violet could be made out. At times I thought I caught traces of other lines, but with no certainty at all. The spindle-shaped beam was also examined with the spectroscope, but only gave the green line. Even in the brightest parts of the red glow, the red line could not be made out. The peculiarity of the moving beam of light was its absolute southern position. Its apparent passage across the sky was only a few degrees above the moon, then at a comparatively low altitude.

J. RAND CAPRON

Guildown, Guildford, November 18

P.S.—In connection with the aurora of last week, it is interesting to notice the great disturbance of the telegraphic needles which has taken place, as I understand, all over the country. At the local post-office here all the longer lines were much affected during Friday and Saturday, sometimes to an extent interfering with ordinary messages. On Sunday morning my own time signal needle, though connected only with a short (mile and a half) wire, showed continuous disturbance; and this morning I have been watching a needle at the post-office which was working independently of any message or induced current from other wires. The effect upon the needle was not violent, but it gradually drew them over to one side or the other, where they remained a short time, and then steadily returned; and by rotating the disc containing the stop-studs, it was easy to follow the considerable deflection which took place. I saw a message sent during one of these deflections. Of course the needle was violently disturbed for the time, but returned to its deflected position afterwards. From inquiries I made, the deflections, whether to right or left, varied considerably, both as to occasions and length of time during which the needle was drawn aside, and there was no special tendency as to direction of the current. From these observations it would seem we have just now aurora in active play around us, though from daylight and other circumstances, not always visible as on Friday night. Saturday and last night I saw no actual aurora, but my assistant thought there was a red glow in the clouded sky of Saturday, and last night there seemed to be a white glow in the east not accounted for by the moonlight.

Since writing the above I learn that the currents have been very strong to-day between 1.30 and 2, and working with London intercepted. The needle generally vibrated to and fro, showing a twisted direction of current.—J. R. C.

Guildown, Guildford, November 20

A MAGNIFICENT aurora was visible here on Friday night, 17th inst., which was remarkable not only for its brilliancy but for the successive changes in its character as the night advanced. At about 4.45 my attention was arrested by a splendid rosy light as from a cloud over-head, though the sun had withdrawn its light from the hill tops at 4 o'clock. It looked like a broad irregular band of cloud stretching across from west to east, but crossing south of the zenith. A little later bundles of rays of light formed in it, slowly waxing and waning; they appeared in the mass much as crystals forming in a concentrated solution, and without, so far as I could see, any parallelism or harmony of direction. Some of them were visible also in the N.E. away from the general mass. At 5.30 the lights were not so bright and by 7 o'clock nothing could be seen. At 8.30 a splendid display occurred. There was still some red light coming up from the west and stretching towards the zenith, but a low corona was displayed in the northern skies. The crown of the arch was magnetic north. Its lower border was a jagged edge upon the dark space below it, formed by broad and narrow bundles of

rays of slightly yellow light all extending radially from the corona very high up over-head. These varied in intensity at different times and seemed to be travelling now east, now west; but the greatest display was at the corona. A band of light similar in character and movement appeared below the corona in the N.N.E., but was not continuous beyond or up to the middle of the arch. Up to this time there had been no rapid flashing of light from the horizon zenithwards. But at 12 o'clock the display was totally changed; waves of light travelling with tremendous velocity upwards from the horizon all round, along certain straight paths momentarily, but repeatedly illumined by them all centreing in a point about 10 degrees south of the zenith formed a magnificent spectacle. It was in plan like an umbrella over one's head, but at the point where the "ribs" should meet the "stick" there was an irregular vortex which looked as if it might be made of clouds, but was not, for it was illumined by the flashes in the same way. At 12.30 it was fading away and when the comet was rising at 3.15, I could see nothing more of it in the east and south, the only directions in which I could see.

R. H. TIDDEMAN

H.M. Geological Survey, Kirkby Stephen,
Westmoreland, November 19

AURORAS of varying brilliancy were seen at York on the 12th, 13th, 14th, 15th, 17th, and 18th (Morning of 19th) November, the 16th and evening of 18th being too cloudy for observation; the 17th giving an exhibition of exceptional brilliancy. On the 13th, 14th, and 17th a low arch was visible (5° to 15° altitude), above which a green light was very evenly diffused for 10° to 20° , then shading off in a more or less patchy manner. Streamers were rare and transient, always of the green light. At 10.15 on the 14th two appeared just west of north, broad, short, but very intense, starting from about $\frac{1}{2}^{\circ}$ below the arch. At 12 on the 17th similar streamers reached 40° to 50° up, the bases being fog-hidden. Each night the display was observed soon after dusk, and was seen to last, on three occasions, till after midnight. On the 7th, at York, it seems to have begun, suddenly, at 5 precisely; the same hour is also given me from Street, Somerset, by Joseph Clark. Seen by me at Leeds from 5.15 to 6 o'clock, masses of an exquisite rose-crimson spanned the heavens, rising from near Arcturus, having Vega near the centre, and reaching down south, at times a few degrees beyond Altair, and northwards to and even beyond Polaris. Hence the illumination passed on to the east and south-east, changing imperceptibly to green near the horizon, the same colour, as on previous evenings filling the northern sky, the arch centre almost due north-north-west (magnetic north). The light was evenly spread, fading gradually into the green (which was faint) on the north, over Headingley, into a very clear sky, brightly lit by the moon on the south, and over Leeds. There were at this time no streamers, no scintillations. The bright areas expanded and contracted rapidly, but yet imperceptibly. At 5.25 a green arch suddenly shot across south of the crimson areas, very defined $1\frac{1}{2}^{\circ}$ to 2° broad, from west-south-west to east-south-east, passing just over the moon. It lasted hardly a minute; the crimson cloud was then bright. Just such a "bar" "shot out" from the south-east at Street, soon after 6, "of yellowish light; it quickly increased in size and brilliancy, and went right across the heavens to the south-west," passing across in less than four minutes. It passed south of the moon (*i.e.* apparent altitude really the same as that at 5.25, Leeds being nearly 3° , 6 diameters of the moon, north of Street). My cousin continued:—"There seemed to be a dark something before the bright bar, which showed the path it would take, also a dark streak where it passed. The postmaster tells me that the telegraph-needle worked very badly this afternoon, turning to the right hand constantly." (The wire runs about north and south for two miles of Street at the south end). The following suggestions arise in connection with this series of auroral displays. Except the brilliant crimson cloud of the 17th, the phenomena on the various nights were very similar; *i.e.* the green glare very uniform, streamers rare, and unusually thick; the low arch over a dark, hazy, apparently cloudy space. It is said that clouds always lie near the north horizon during auroras in Great Britain. Is it certain that these in some cases may not be part of the special phenomenon? Certainly, I have always found it look cloudy. If such were the case 100 miles or more south of Leeds on the 17th, such "clouds" must have been where, from Leeds, the south to south-west horizon looked specially clear. Again, is the apparent shadow before an advancing ray or bar only an illusion? It certainly is a not unusual

impression. That the bars of bright light seen at Leeds and Street occupied the same relative elevation is striking. If such phenomena are produced at heights of about 50 miles, and supposing the moon's altitude were 25° , the bar seen at Leeds about 5.25 should have passed a little south of the zenith at Birmingham, a few degrees below the Pole Star near Gloucester, and 30° from the north horizon at Street. Again, do we view an actual *object* in auroral displays, and not, as the rainbow, a subjective impression only? If we do, and the display were 50 miles high, the altitude of Atair being, then, about 40° , this southern limit of the red cloud would be about 40° north of the zenith at Birmingham, 30° at Gloucester, under 20° at Street. If it was more extended, then either the display must exist at a much greater altitude, or it must be in some way subjective in nature. If it were 100 miles above us, or far higher than is now usually supposed, still the limit of the display would have been 10° south of the zenith at Birmingham, 10° and 35° north of it at Gloucester and Street respectively. For at Leeds, from 5.15 to 6 o'clock, the southern limit reached rarely and only a few degrees below Atair. Finally, since auroras are likely to be frequent at present, could not a regular corps of observers be organised over the United Kingdom, as has been done in the case of meteors? A few data accurately recorded for time and position at two or three localities, would settle definitely the above question, and if auroras are actual objects, the height of the display. The *lower*, well-defined edge of arches, angular height, and point of the compass of streamers, and limits of the coloured clouds might all be determined with comparative ease by star reference.

Bootham, York, November 18

J. EDMUND CLARK

P.S.—November 19. A sixth aurora last night, seen at 5.45 a.m.; the comet as well defined as a month ago, except the nucleus.

LAST evening there was a very fine display of the aurora borealis visible in York. I noticed it first at 5h. 15m. in the west: a large patch of brilliant rose-coloured light sprang from the western horizon, and extended some 30° or 40° towards the zenith, tipped by a fringe of pale yellowish-green light; so bright was the colour, as to be suggestive of an extensive conflagration in the neighbourhood. This bank of coloured light gradually extended northward in the form of an ill-defined arch, when suddenly, about 5.45 p.m., another brilliant bank of rose-coloured light sprang up due east, and was joined by the arch extending from the westerly bank of light. Above this arch were extensive streamers of greenish-yellow light extending past the constellations Taurus, Ursa Major, Cygnus, Lyra, Aquila. A second arch of greenish light subtended the eastern and south-western sky, and stretched from Taurus beyond to the south of Aquila to the horizon. The effect was very splendid, for inside this arch of light the moon was shining brilliantly. I have rarely seen so grand a display in these latitudes, and never where the colour was so brilliant. It gradually faded away, and was very feeble when I last saw it, at 7.15 p.m. I watched the ever-changing scene for about an hour. During the month there have been several large spots on the sun, which I have observed each day that it was possible to make an observation, with a $\frac{1}{4}$ -inch refractor by Cooke.

H. CLIFFORD GILL

Bootham, York, November 18

P.S.—I see in this morning's paper that the telegraphs have been seriously affected by the magnetic storm, not only in England, but on the Continent.

A FINE aurora was visible from here last evening. When my attention was first called to it a few minutes after 5, the whole northern half of the heavens was suffused with a ruddy glow, as though there was a fire in the neighbourhood. Without paying further attention to its general appearance to the eye, I at once proceeded to examine it with a spectroscope, and found a distinct and sometimes quite bright green band. By the aid of a micrometer scale attached to the spectroscope I took about half a dozen readings of the position of the green band, and successively compared its position with that of one of the bands in the spectrum of the flame at the base of a Bunsen burner. My readings were necessarily taken hastily, but they uniformly agreed in being nearly coincident with, but slightly more refrangible than, the band of wave-length 5581, in the flame of the Bunsen burner. The green band was certainly nearer the hydrocarbon band of wave-length 5581, than to the next one in the same group, on the more refrangible side of wave-length 5542, and so agrees well with Ångström's measure-

ment 5567. The ruddy colour varied in intensity and position for about an hour, and soon after six disappeared. I found the green band was easily seen by directing the spectroscope to parts of the sky, on the northern side, even when without it, one would not have noticed any unusual appearance. I also thought I saw indications of blue or indigo bands, but I could not identify any with certainty. Later on in the evening, from about half-past seven till a quarter to nine, when the sky was much clearer and the stars and moon were bright, now and then the aurora was very brilliant; but the light was green except just once towards the last, when at about 60° or 70° from the horizon, the ruddy glow appeared for a few moments. About half-past eight the sky from the horizon to about 30° was suddenly so brightly green, that had I not known of the aurora, I should have imagined the appearance was due to green fire. About this time fine green streamers frequently shot upwards to a great height. Unfortunately during the latter part of the display I had no spectroscope with me to make further observations.

HENRY ROBINSON

University Chemical Laboratory, Cambridge,

November 18

MAY I ask space for the record of an observation made during the fine auroral display of Friday evening, which if compared with similar observations made at other stations may serve to determine with considerable accuracy the height above the earth at which the display took place? For the sake of better observation of the aurora I had gone up to the Durdham Downs by which Clifton is bordered to the north, and from which one has an almost uninterrupted horizon in all directions. The sky was every where very clear, even close to the horizon, and the auroral arch was very conspicuous in the north; its summit lying between the stars Delta and Epsilon in the Great Bear. At 3 minutes past six o'clock a brilliant elongated patch of greenish white light appeared suddenly in the east, below Saturn and to the right of it, the centre of the patch being about 8 degrees from Saturn on a line drawn through the planet at an angle of 45° with the horizon. When first seen the patch was about 6 degrees in length and half a degree in width and the ends had a rough splintered appearance. It rapidly increased in length and less rapidly in thickness, till it closely resembled in general appearance the great Nebula in Andromeda as seen with a good telescope, and the length of the conspicuously luminous portion was apparently about as great as the distance between the stars Alpha Pegasi and Delta Andromedae, i.e., about 27 degrees. The breadth at the centre seemed about equal to twice the moon's diameter. I expected it to lengthen out into an arch across the sky like other fainter ones, which were visible at the time between it and the arch to which I have already referred, but instead of doing so the patch began to shift rapidly across the sky end foremost, as if ascending the eastern slope of the arch which I had expected it to form, then after reaching the summit where its length was horizontal, it rapidly descended the western slope and disappeared near the horizon, 'passing close under the moon at a distance which I estimated immediately afterwards as rather less than three times the moon's diameter, (measuring from the centre of the luminosity to the moon's lower cusp). The duration of the phenomenon was hardly a minute and its brilliance far exceeded that of any other portion of the display. My colleague Mr. Jupp, who observed a portion of the phenomenon from another place estimated the distance from the moon's cusp as four moon's diameters. The width at the centre we agree in estimating at two moon's diameters. It is not, I believe, often that any portion of an auroral display is so easily distinguished from the rest and localized as this was.

A. M. WORTHINGTON

Clifton College, Bristol, November 19

AN auroral display of unusual magnificence, and lasting upwards of four hours, was observed here last evening. At about 5h. the northern quarter of the sky from the horizon to the zenith, was covered with a delicate crimson glow of surpassing beauty, which included evanescent streamers of a deeper tint. These were succeeded by others of a creamy-white colour, which were more persistent, but did not attain so great an altitude. At 6h. 5m., when the display was at its maximum, a remarkable phenomenon was seen—a bright greenish-white band of a lenticular form, about 20° in length and 5° broad (its axis being parallel to the horizon in the south), passed from the south-east to the south-west horizon, attaining an altitude, when due south, of about 20° . It occupied about six seconds in passing from horizon to horizon, and its brightness seemed to be but slightly

affected by the light of the moon, which was shining in the south, and below which it moved. The light of the rosy streamers, when first examined at 5h. 15m. with a small direct-vision spectroscope, gave two very distinct bright lines, one in the red (presumably near C), and the other in the green. There was a faint continuous spectrum towards the more refrangible end, but no traces of other lines. Afterwards, when the display was at its best, only the bright line in the green was observed, but it was much more brilliant than before, and could be traced in every part of the sky except in the south. It was weak in the zenith, but towards the north horizon it stood out with extraordinary distinctness, and was especially strong in the lenticular band seen at 6h. 5m. This line could be easily seen in the northern sky when all signs of the aurora had apparently passed away. At 7h. 45m. the glow assumed the form of a well-defined arch, extending from the north-east to the north-west horizon, and reaching an altitude of about 30°. It remained more or less distinct till 8h. 30m., after which time the light gradually diminished, till at 9h. the sky assumed its usual appearance. During the greater portion of the evening the sky was perfectly cloudless. This display was certainly finer than that seen on October 25, 1870, and though fewer bright lines were observed in its spectrum than on that occasion, the two which were seen were far better defined, and much more brilliant.

Kempston, Bedford, November 18 THOS. GWYN ELGER

ON last Friday afternoon at 5.15 I observed in the north a magnificent auroral display. The moonlight mixed with the fading twilight was of course unfavourable to the brilliancy of such a phenomenon: notwithstanding which the auroral glare—suggestive of rose-coloured clouds, alternately intensifying and fading—was a very remarkable spectacle. A sharp frost supervened.

C. ROSE INGLEBY

Valentines, Ilford, November 20

A BRILLIANT auroral display was observed here last night. I first noticed the pale auroral arc at 5h. 30m., the top of the arc at that time being just below Merak and Phecta in Ursa Major. At 5h. 40m. red streamers were seen in the north-west and shortly afterwards in the north-east, and then at intervals pale streamers were observed all along the arc. For about five minutes a double arc was visible, a band of dark sky intervening between the two, which combined to form one broad arc, and remained so to the end of the display. At 6h. there was a very apparent waning of the streamers, and at 6h. 30m. they had entirely disappeared. The auroral-arc remained until about 9h. 30m. With a Browning's miniature spectroscope I saw the green line very distinctly, while the red streamers appeared to show a very faint red band. Perhaps it is worthy of notice that the sky, which to the naked eye was dark, showed on examination the characteristic spectrum.

C. H. ROMANES

Worthing, November 18

ANOTHER splendid display of aurora was seen here last evening, commencing at 5.10 with a column of rose-coloured light in the north-west, which, rapidly becoming diffused, spread upwards to the zenith, a similar glow being visible in the east. In the northern horizon a double arch of white light extended from beyond Capella to the north-west, from time to time shifting its position and increasing in altitude till the two arches had melted into one, from which rosy streamers went upwards. But lovelier and more wonderful even than this display was a shaft of intense white light, which, just as the chimes of the old church clock were dying away at 6, passed rapidly like a flying arch across the heavens at an altitude of about 30 degrees, and vanished below the southern horizon. After 6.45 the rosy tint's had gradually subsided, and at 8 a pale light in the north was all that remained, but I have been told that at 12 and 3 a.m. coloured streamers were again visible.

E. BROWN

Further Barton, Cirencester, November 18

THE fine display of the aurora borealis was seen here Friday evening from a little before 6 o'clock. The sky was clear, and the moon, seven days old, was well up. The chief features of the aurora were the two patches of deep pink light, one in the west, in the constellation Hercules, and the other in the east, between Capella and the Pleiades; connecting these two patches was an arc of lighter tint passing between the two Bears. At 6.10 a beam extended from this arc to the left of Cassiopea, towards the zenith; at 6.20 this had disappeared, and another very distinct lay through the body of Ursa Minor, right to the zenith, more over the concentration, as it were, of pink light

near Perseus in the east had disappeared, and the light ended at Capella. At 6.40 Capella and β Aurigæ were clear of it. The patch in the west did not disappear, but grew fainter. At 6.50, while watching the display, a magnificent meteor fell slowly from the body of the Little to the tail of the Big Bear, leaving a short red tail there. At 7 the pink tint of the auroral arc had almost disappeared, giving place to one of phosphorescent light, extending from near where Jupiter was rising in the east, through the body of Ursa Major, to below Hercules in the west. This grew fainter, till at 7.30 it was scarcely noticeable. But at a little before 11 p.m. there extended a narrower and brighter line of phosphorescent light, slightly arched from 10° to 15° above the horizon. From this, at 11.20, the streamers began to radiate towards the zenith, alternately forming and disappearing, some stretching to the zenith, some only half way. At 11.45 repeated flashes of light swept up along the streamers, happily likened by one of your correspondents to the flapping of a flag in a breeze. At times a long streamer would appear broken off from the arc of light, and fade away. At 12 the streamers had vanished, leaving only the phosphorescent light near the horizon, though now and then a streamer would form. At 12.30 a pink tint appeared in the north-east, and more streamers formed till 12.45, when the light began gradually to fade away, till at 1 a.m. nothing of the display was to be seen. The day had been overcast, wind north, but towards evening it had cleared; during the night it was freezing; the barometer, at 29.6, was rising; the moon had set at 11 p.m., and the sky, free from clouds, was all that could be desired in which to witness this splendid display of northern lights.

FRANK STAPLETON

Oxford, November 19

I BEG to hand you an account of the extraordinary apparition of Friday evening last, November 17, as seen at Clevedon, during a brilliant rose-coloured aurora. The time was about 6.15 p.m. There rose suddenly, through the haze in the east, a beam of light, at an angle of some 60° with the horizon. It crossed the cloudless sky rather below the moon, and sank in the west, occupying about eighty seconds in the transit. The trajectory was much flatter than that of the stars, &c., but was at right angles to the meridian, which was crossed at an approximate altitude of 22°. I estimated the length of the beam at 35°, and the breadth at the middle to be 3°; from whence it tapered gradually to a point at each end. The colour was uniform throughout—a very pale yellowish white, without corrosion or change; and there was no indication of a trail, or of any sort of atmospheric disturbance. The impression conveyed to me was that the beam was stationary in space, and comparatively near, and that we were being carried past it by the rotation of the earth. The major axis lay on the apparent path, but in the earlier and latter parts of the course it was much foreshortened; and as the western horizon was approached, a formation of a similar character, perhaps 7° northward, and running on a parallel track, was visible for several seconds before both were lost in the trees. This second object was also noticed by others whose view westward was less interrupted. I watched the whole evening without seeing any tendency to a repetition of the phenomenon. The sky remained cloudless, with the temperature at the freezing point. There was no wind; and the aurora, which continued off and on until past eleven o'clock, at no time threw out any considerable rays or streamers. The strange visitor caused great commotion among the many who were out of doors looking at the aurora, some of them fearing that the supposed runaway comet was coming into collision with the moon, then half an hour past the meridian, and relieved when it passed below it. I had, however, a much better corroboration of the altitude above given, a careful observer who was with me placing a rod in the direction of the supposed meridian passage. The angle closely agreed with my estimate. We now require to know at what place south of this the beam was seen to cross the moon's disc, for computing the actual distance and position. Many of your readers will not have failed to note that a splendid aurora again coincides with rapid and striking changes in the configuration of a gigantic spot in the sun. With a 3½-inch achromatic, I was able on the same afternoon to observe those changes from hour to hour, on a scale I never before witnessed.

STEPHEN H. SAXBY

East Clevedon Vicarage, Somerset, November 20

WHILE watching the grand display of aurora on Friday night from our roof, at about 6h. 7m., my wife and I saw a strange gleam of light rising above a bank of cloud on the eastern

horizon, nearly vertically below the Pleiades, like the gleam of another moon rising in a haze. It grew out slowly, as we watched it, into a strong beam of white light slanting towards the south, and we stood in wonderment as it lengthened out making straight towards the moon. Presently its tail was disengaged from the cloud, and it stole through the sky like a long luminous nebulous "cigar ship" exactly across the moon, and away down into the west, sinking as slowly as it had risen. In the middle of its course it was, as well as I could estimate, about 40° in length and about 5° in width. The ends were, I think, slightly tapering and hazy; the sides pretty well defined. I did not notice if the moon's crescent was at all blurred during the passage; my wife is under the impression that it was. The time occupied from first appearance to final disappearance was about one minute. You will probably receive many accounts of this strange apparition. It will be interesting to know the position relative to the moon in which it was seen by different observers. Was it clear of the earth's atmosphere or not?

Woodbridge, November 19

HUBERT AIRY

YOU will no doubt have abundant accounts of Friday's aurora. I have received the following from a correspondent in North Devon, dated Friday 6.5 p.m. . . . "As we watched, a brilliant comet (apparently) appeared near Saturn" [which must have been low down, a little N. of E.] "and in a direct line between Saturn and the moon" [at that hour nearly in the meridian and 28° in altitude]. "It was about twice as big as the comet." [Here follows a sketch, which the above 'asides' render it unnecessary to copy.] "It travelled stern foremost towards the moon, and was in sight a full minute. As it disappeared it seemed to leave a black cloud of its own shape which also disappeared in a few seconds (an optical delusion perhaps)." It does not appear to have occurred to the writer that this appearance was itself auroral.

J. HERSHEY

30, Sackville Street, November 18

I AM unable to explain the following occurrence which I observed this evening at 6h. 5m. p.m. It appeared to be a well-defined spindle-shaped body of a cloudy consistency, having a brilliant white colour. It subtended a visual angle of about 20° degrees. I first observed it due east, and immediately noticed that it was moving with very great rapidity, as in less than one minute it had disappeared below the horizon in the south-south-west. There was a rosy aurora visible at the time in the north, which, however, was in no way connected with it. The atmosphere was perfectly clear in that part of the heavens traversed by the phenomenon, though in other parts of the sky there were a few stationary clouds visible. A friend who was with me at the time will corroborate all my statements. As I am utterly at a loss to explain this phenomenon, I would be much obliged for any suggestions or explanations from your readers.

A. S. P.

Cambridge, November 17

I THOUGHT that many of the readers of NATURE would be interested in a curious phenomenon which appeared during the beautiful coloured aurora on the evening of the 17th. I was watching it from a position commanding a large view of the sky, when, as I was looking south-east, a long patch of white light appeared about 10° above the horizon. This was commonplace at first, but then it quickly developed into a long, gleaming, and well-defined streak. It looked very like two brilliant comets joined end to end by the tip of the tail. This took about a minute to form, and when complete, it started off in the direction of its length in a curved path which gradually rose above the horizon until it culminated at an elevation of 30° on the magnetic meridian; after which the west end inclined downwards, and it continued its journey in inverse order to the south-west, keeping its symmetry and shape like a rigid body all the way, until it reached a position in the south-west, corresponding to its place when forming, and here it halted and dissolved away. The band of light was about 30° long, and beautifully curved along its path. It took about three-quarters of a minute in its transit, which occurred at 6 p.m. It was an extraordinary sight, and I hope some one else has observed it. During the phenomenon, the aurora in the north-east and north-west (magnetic) was very fine, showing rich red and apple-green streamers; these were very steady all the time. I have made a sketch of the band of light, as nearly as I can remember it. It was very bright, even when under the moon. I think this sketch gives a good idea of it, and I inclose it in case it be wanted. The southern sky was quite clear at the time.

H. D. TAYLOR

Haworth, York, November 19

ON Friday, November 17, we had a great auroral display at 4.30 before sunset, and continuing till 5.30, the heavens were aglow with auroral light of a rosy tint, changing, occasionally into silver grey. A haze overspread the sky until 10 o'clock, from which hour till 2 a.m. Saturday the sky was brilliant with aurora. The streams of light culminated near the zenith, and at midnight the magnetic storm appeared to reach its maximum. The magnetic disturbance must have been great for several hours, as nearly all telegraphic operations had to be suspended.

Newcastle-on-Tyne, November 19

T. P. BARKAS

ABOUT 5.20 p.m. on Friday last I witnessed the most remarkable auroral display I have ever seen, and as it only lasted a few minutes, may have escaped the attention of many. My attention was first attracted by a broad crimson band stretching quite across the sky, and almost coinciding with the Milky Way. Some of the bright stars could be seen through it, but gradually it became opaque at the zenith and appeared to concentrate around an opening, forming a complete corona, out of which the rays seemed to boil over and dart out in every direction, but chiefly northwards. It was a most weird-looking sight, and reminded me of "The Glory," as shown in pictures of Saints. Overhead it rapidly faded away, but bright streamers were visible up till 9 p.m., when a thick fog came on.

W. MAKEIG JONES

Wath-on-Dearne, Rotherham, November 20

IN connection with the recent appearance of the aurora borealis, a remarkably large sun-spot was visible to-day, occupying a position in about the middle of the disc. The spot might be called an aggregation of spots, from its area. Several minor spots were also visible, which were discrete.

Rugby, November 19

GEORGE RAYLEIGH VICARS

THERE was visible here on Friday, the 17th, between 5.30 and 6 p.m., a display of aurora. My attention was called to it by the ruddiness of the sky towards the north, and I continued watching it till near 6 o'clock. The sky was clouded with cumulo stratus, and the stars only visible here and there through the intervals of these clouds. The centre of the ruddiness or glow appeared to be over Auriga, the most brilliant star of which group was just visible. It extended to the east so as to cover Gemini, and about an equal distance west. It shifted and varied very rapidly, maintaining its ruddy colour, and this very rapidity of shift assured me that it was really an aurora. After 6 o'clock p.m. the clouds nearly completely covered the sky, and neither at 7 o'clock nor at 8 o'clock did I see any further sign of the appearance. I could not distinguish any beams whatever.

J. P. O'REILLY

Royal College of Science for Ireland, Stephen's Green,
Dublin, November 18

P.S.—I was informed that on the evening of Thursday a similar display had been noticed.

AT about 6.5 p.m. on Friday a bright, white, cloud-like object, in shape like a fish-torpedo or a weaver's shuttle, was observed to cross the heavens from east to west. Its length was roughly about 30° , and its breadth about 4° . I noted it first shoot up, like a strong electric ray in a fog, a little south of Aldebaran, and slowly, as it were, slide along at the same N.P.D. across the face of the moon (which was shining brightly at the time), and disappear in the west under Altair. Its surface had a mottled appearance; its colour white; its motion was slow, being visible, from horizon to horizon, upwards of 50 seconds; its brightness was strong, and did not seem to fade, even when crossing the moon, and it seemed preceded and followed by a strong black margin; though this I suppose was the effect of contrast and subjective only. The aurora was noted here from 4.30 on Friday till about 5 a.m. on Saturday.

JOHN L. DOBSON

Baumont College, Old Windsor, November 21

THE CHLOROPHYLL CORPUSCLES OF HYDRA

IN the last number of the *Zeitschrift für wiss. Zoologie* is an article by Mr. Hamann, assistant in the Zoological Institute of Jena, on the "Origin and Development of the Green Cells in Hydra." I cannot allow